

The activities of the International Precipitation Working Group

*Chris Kidd, Remy Roca, Ralph Ferraro
and the IPWG community*



WMO, CGMS & IPWG

WMO: World Meteorological Organisation

CGMS: Coordination Group for Meteorological Satellites

IPWG: International Precipitation Working Group

CGMS members include: CNES, CMA, CNSA, EUMETSAT, IMD, ISRO, IOC/Unesco, **JAXA**, JMA, KMA, **NASA**, **NOAA**, ROSHYDROMET, ROSCOSMOS, ESA, and WMO; observers include CSA, ENV CAN, GCOS, KARI, KIOST, and SOA.

CGMS has five International Science Working Groups (ISWGs) :

International TOVS Working Group: ITWG

International Precipitation Working Group: IPWG (400+ members)

International Radio Occultation Working Group: IROWG

International Winds Working Group: IWWG

International Clouds Working Group: ICWG



NASA PMM Science Team meeting, Houston, TX
24-28 October 2016



IPWG Objectives

- 1) Promote standard operational procedures and common software for deriving precipitation measurements from satellites
- 2) Establish standards for validation and independent verification of precipitation measurements
- 3) Foster the exchange of data on inter-comparisons of operational precipitation measurements from satellites
- 4) Stimulate increased international scientific research and development in this field
- 5) Provide recommendations to national and international agencies regarding the utilization of current and future satellite instruments on both polar and geostationary platforms
- 6) Encourage regular education and training activities



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CGMS



IPWG activities

- Provide recommendations to CGMS related to:
 - current, planned and future precipitation missions, and;
 - development, assessment and utilisation of precipitation algorithms and products.
- Working groups (helping to identify recommendations):
 - Research working group
 - Data assimilation working group
 - Applications working group
 - Scattering working group
 - Validation working group
- Continuing intercomparison of satellite-derived precipitation products over diverse validation regions

Examples of IPWG support:

- GPM 166&183 GHz channels for light rain/snowfall
- Continuation of coverage over the Indian Ocean (*Meteosat-8 will now be positioned at 41.5°E, 2017*)
- Utilization of post-operational satellites – *once METOPC is operational, METOPA will be allowed to drift*
- Extension of inter-comparisons to other regions – *development and operation of site over South Africa*
- Training sessions for students and users
- Special journal issues (*e.g. JHM, 21 papers*)
- Instigation of positioning papers on satellite precipitation estimation.

Co-chairs and Rapporteurs

Co-chairs are selected for a 2 year term and work in parallel with the outgoing co-chairs

Years	Co-chairs*	Rapporteur
2001-2004		James F. W. Purdom
2004-2006		
2006-2008		
2008-2010		
2010-2012		Volker Gärtner
2012-2014		
2014-2016		
2016-2018		Ralph R. Ferraro

IPWG Meetings

- *Formation Meeting: June 2001, Fort Collins, CO*
- *IPWG-1: Sept. 2002, INM, Madrid, Spain*
 - *GEWEX/GPCP 2003*
- *IPWG-2: Oct. 2004, NRL, Monterey, CA*
 - *PEHRPP, June 2005, Irvine, CA*
 - *1st IWSSM, Oct. 2005, Madison WI*
- *IPWG-3: Oct. 2006, BoM, Melbourne, Australia*
 - *PEHRPP, Dec. 2007, WMO, Geneva, Switzerland*
 - *2nd IWSSM, Mar/Apr 2008, Steamboat, CO*
- *IPWG-4: Oct. 2008, CMA, Beijing, China*
- *IPWG-5: Oct. 2010, MPI, Hamburg, Germany*
 - *3rd IWSSM, Mar/Apr 2011, Garmisch, Germany*
- *IPWG-6: Oct. 2012, CPTEC, São José dos Campos, Brazil*
 - *4th IWSSM, May 2013, Mammoth Mtn. CA*
- *IPWG-7: Oct. 2014, JAXA, Tsukuba, Japan*
- *IPWG-8: Oct. 2016, CNR, Bologna, Italy*
 - *+5th IWSSM, Oct. 2016, Bologna, Italy*



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CGMS



IPWG-8 & IWSSM-5

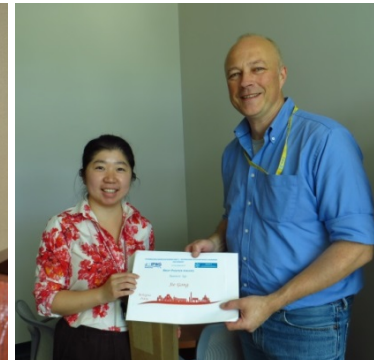
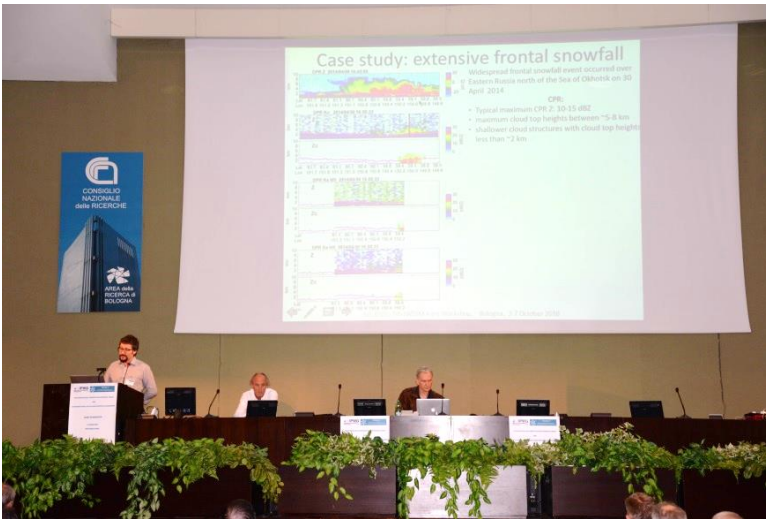
CNR, Bologna, Italy 3-7 October 2016

63 oral presentations

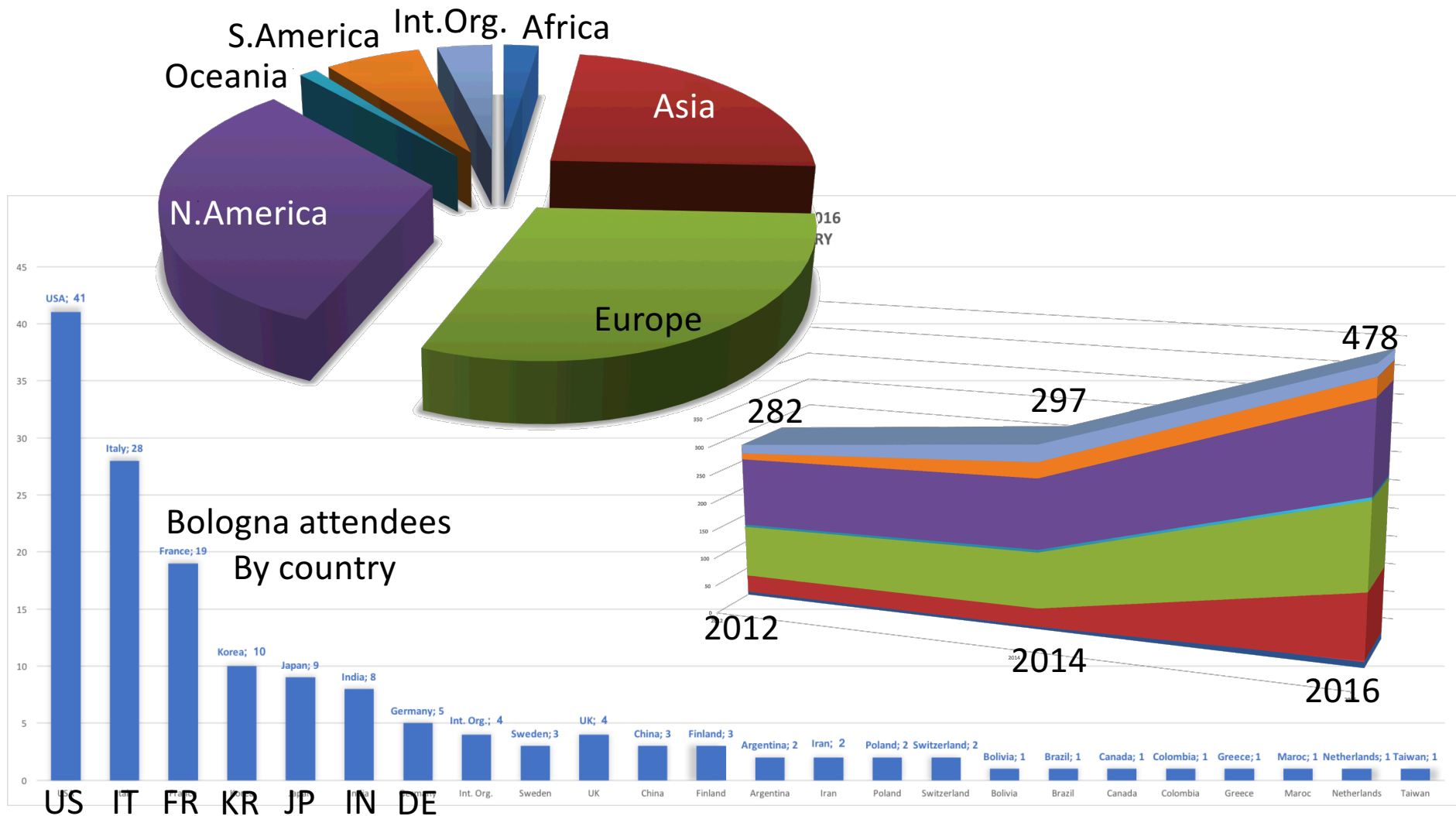
88 poster presentations

158 participants from 23 countries

poster prizes for early career scientists
(Sponsored by Vincenzo Levizzani & Chris Kidd)



IPWG membership/attendance



Working Group outcomes (I)

Validation Working Group:

- IPWG: broaden IPWG validation to include under-represented countries
- IPWG: Uncertainty assessments – initial pass using climate classification
- IPWG: *L2/swath validation* – interaction with EUMETSAT H-SAF
- IPWG: validation of snowfall products
- IPWG: standardisation of validation procedures – *GPCC daily/monthly*
- ➡ CGMS: maintaining in situ observations and access to hitherto inaccessible surface data.

Applications Working Group:

- IPWG: Update training links on web page
- ➡ GCMS/WMO: maintain/coordinate constellation with SSMI/ATMS-class
- IPWG: Generate review paper of satellite products and usability
- IPWG: links to data, processing and analysis tools
- ➡ WMO: improved access to surface data to improve satellite estimates



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Working Group outcomes (II)

Research Working Group:

- IPWG: Improvements are needed to:
 - high-latitude precipitation estimates;
 - shallow/orographic precipitation, and;
 - land surface emissivities.
- IPWG: comprehensive validation of oceanic precipitation needed
- ➡ CGMS: Enhance spatial and temporal resolution to improve our understanding of microphysical processes
- IPWG: exploit new generation of multispectral vis/IR GEO sensors
- ➡ CGMS: coordination of PMW sensors – current, planned & future
- ➡ CGMS: accessibility to GEO data <1 hour



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Working Group outcomes (III)

Scattering Working Group:

- IPWG: Interface needed between users and providers of scattering info.
- IPWG: Need to decouple scattering from RT code for flexibility
- ➡ CGMS: support needed to fully exploit microphysical/scattering in precipitation retrievals

Data Assimilation Working Group

- ➡ CGMS: Incorporate data assimilation requirements when developing new missions
- IPWG: regular scientific workshops on cloud/rainy data assimilation
- ➡ CGMS: high temporal/spectral PMW sampling of clouds/precipitation
- IPWG: coordination across CGMS ISWGs for cloudy data assimilation
- ➡ CGMS: improved latency needed to improve ability to fit DA requirements
- ISWGs: coordinate/develop validation strategies



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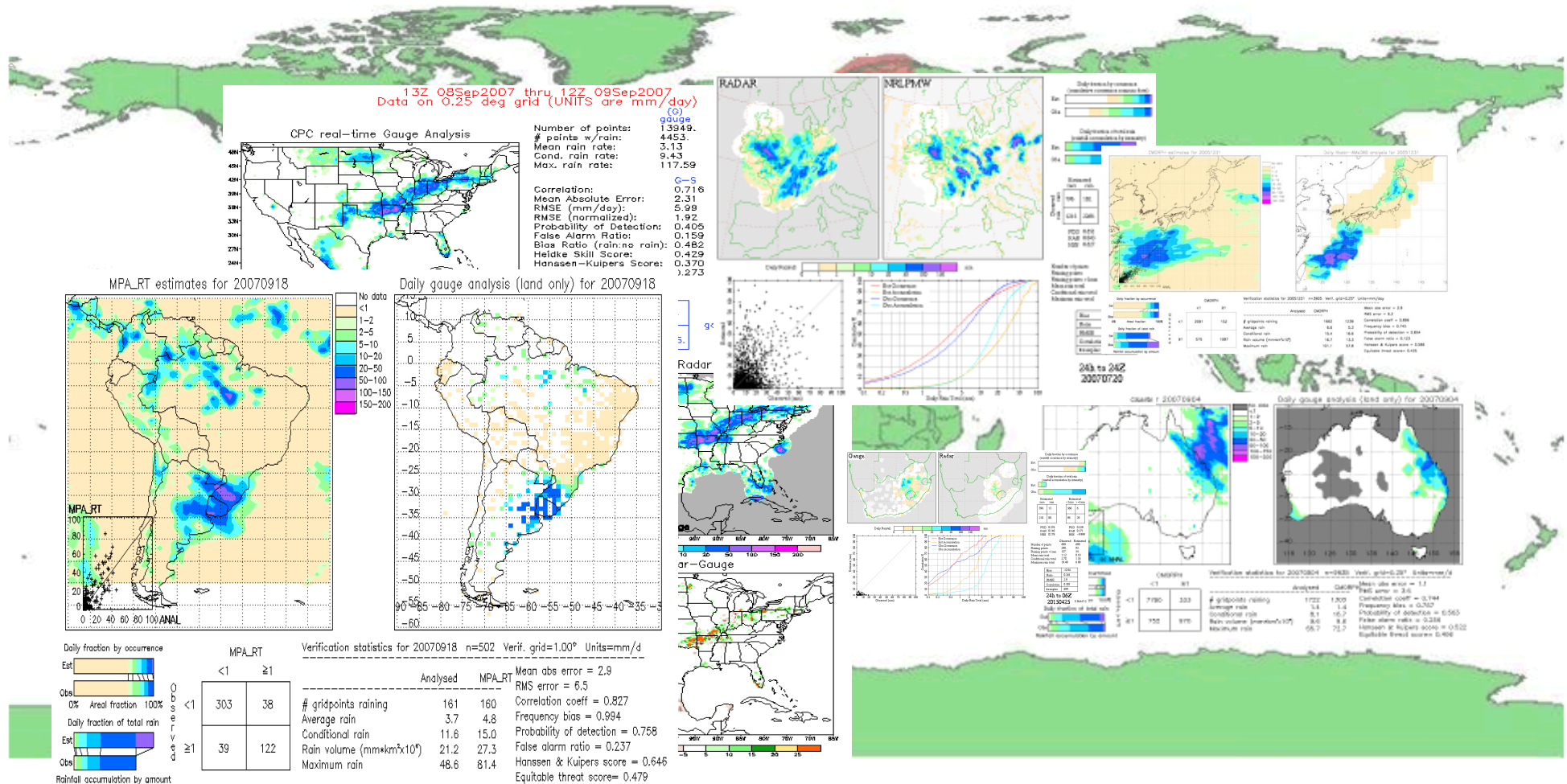
Key outcomes: IPWG...

- acknowledges some progress in sustaining the precipitation constellation (e.g. EUMETSAT, CMA, NOAA).
- asserts the need for the formulation of a coordinated plan towards a sustainable MW-based constellation
- notes the need to account for user (Drought, hydrology/hydrology) requirements for temperature and humidity observations.
- notes the continuing need for the development of new sensors: 1xMWI, 1xMWS, 1xATMS
- recognises the need for training activities for mid-high latitudes
- backs training activities (e.g. support) on an annual basis, with a summer school possible for 2017/2018
- recommends further support/encouragement to involve more nations in IPWG validation effort (e.g. India, China)

IPWG Inter-comparison regions



Near real-time inter-comparison of model & satellite estimates vs radar/gauge



IPWG - <http://www.isac.cnr.it/~ipwg/>

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Accessing IPWG intercomparisons



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- [WMO](#)

IPWG VALIDATION LINKS

- [IPWG Ground Validation Data Links](#)

IPWG VALIDATION EXERCISE

- [Australia - SatRainVal](#)
(Validation / intercomparison of daily satellite precipitation estimates -- An IPWG project)
Pages temporarily down.
- [Europe, focal point Chris Kidd](#)
 - [Validation page](#)
 - [Instantaneous inter-comparisons](#)
- [Japan - \(GSMaP\) Team](#)
 - [Validation / intercomparison of satellite precipitation estimates over Japan](#)
 - [Daily validation results for daily precipitation estimates, focal point Shoichi Shige](#)
- [South Africa - Validation Page, focal point Estelle de Coning](#)
- [South America - Validation Page, focal point Daniel Vila](#)
- [US - Validation page, focal point Ralph R. Ferraro](#)

CALIBRATION

- [Radiometer Level 1C data from Colorado State Univ.](#)

Main IPWG
Inter-comparison
Web sites

Regional Web pages - Japan

[Home](#) [Validation results during 2003](#) [Validation results during 2004](#) [Validation results during 2005](#) [Validation results during 2006](#) [Validation results during 2007](#) [Validation results during 2008](#) [Validation results during 2009](#) [Validation results during 2010](#) [Validation results during 2011](#) [Validation results during 2012](#) [Validation results during 2013](#) [Validation results during 2014](#) [Validation results during 2015](#) [Validation results during 2016](#)

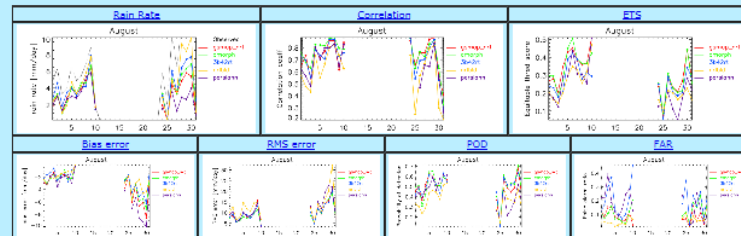
Daily validation results for daily precipitation estimates

Click [here](#) to go to the CAWCR validation page for the Australia.
Click [here](#) to go to the U. Maryland validation page for the US.
Click [here](#) to go to the NASA GSFC Precipitation validation page for Europe.
Click [here](#) to go to the U. Maryland validation page for South America.

September 2016

---	Gauge, PMW, and IR	Blended PMW and IR										Merged PMW Only						IR			IR & VIS	WGNE-NWP				GSMap hourly
Valid Date (12-12 UTC)	GSMap_Gauge	GSMap_NOW	GSMap_NRT	GSMap_MVK	NASA (3B42RT)	NASA (IMERG_NRT_E)	NASA (IMERG_NRT_L)	CPC (CMORPH)	PERSIANN	NRLBLD	NASA (3B42RT)	NASA (IMERG_NRT_E)	NASA (IMERG_NRT_L)	CPC (MPCOMB)	MSR3	MSPPS	NASA (3B42RT)	NASA (IMERG_NRT_E)	NASA (IMERG_NRT_L)	NESDIS (HYDRO)	JMA	ECMWF	GFS	MetOpR	BoM	Valid Date
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20160922	GSMap_Gauge	GSMap_NOW	GSMap_NRT	GSMap_MVK	3B42RT	Cal Uscat	Cal Uscat	CMORPH	PERSIANN	NRLBLD	3B42RT	IMERG_NRT_E	IMERG_NRT_L	MPCOMB	---	---	3B42RT	IMERG_NRT_E	IMERG_NRT_L	HYDRO	---	---	---	---	---	20160922
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August 2016



	Gauge, PMW, and IR	Blended PMW and IR										Merged PMW Only						IR				IR & VIS	WGNE-NWP				GSMap hourly
Valid Date (12-12 UTC)	GSMap_Gauge	GSMap_NOW	GSMap_NRT	GSMap_MVK	NASA (3B42RT)	NASA (IMERG_NRT_E)	NASA (IMERG_NRT_L)	CPC (CMORPH)	PERSIANN	NRLBLD	NASA (3B42RT)	NASA (IMERG_NRT_E)	NASA (IMERG_NRT_L)	CPC (CMORPH)	MSR3	MSPPS	NASA (3B42RT)	NASA (IMERG_NRT_E)	NASA (IMERG_NRT_L)	NESDIS (HYDRO)	JMA	ECMWF	GFS	METOPR	BoM	Valid Date	
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Daily images and statistics and summary plots!
Probably the best run web page at present!



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24-28 October 2016



European Instantaneous Inter-comparisons

Instantaneous inter-comparisons

[\[Overview | Background | GPM | Data | Validation | Links | Contact \]](#)

2014

January 2014						
S	M	T	W	T	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

February 2014						
S	M	T	W	T	F	S
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16	17	18	19	20	21	22
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March 2014						
S	M	T	W	T	F	S
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09	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

April 2014						
S	M	T	W	T	F	S
		01	02	03	04	05
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27	28	29	30			

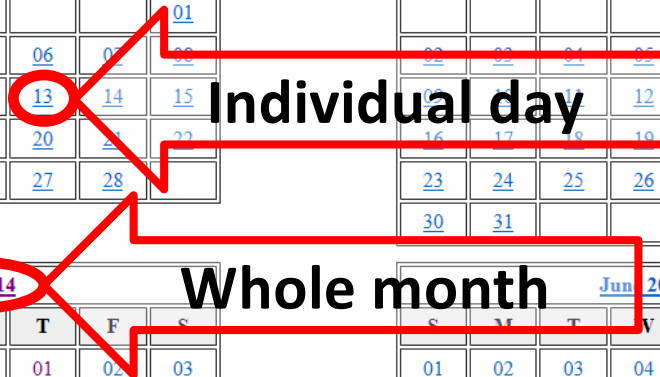
May 2014						
S	M	T	W	T	F	S
				01	02	03
04	05	06	07	08	09	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

June 2014						
S	M	T	W	T	F	S
01	02	03	04	05	06	07
08	09	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

July 2014						
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August 2014						
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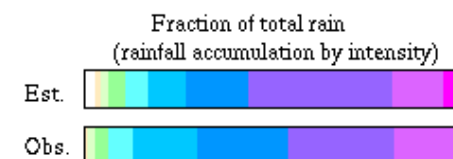
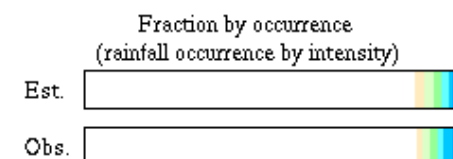
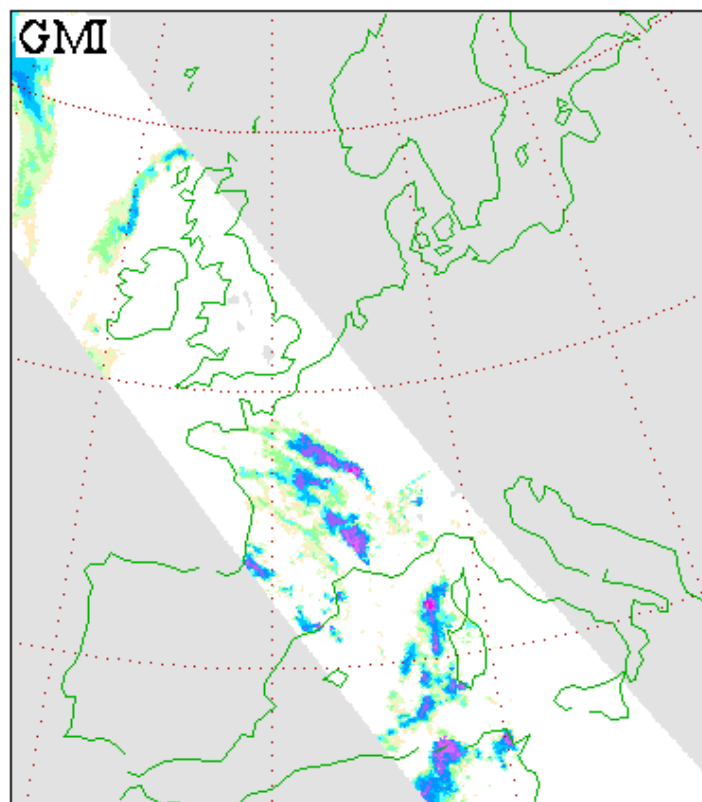
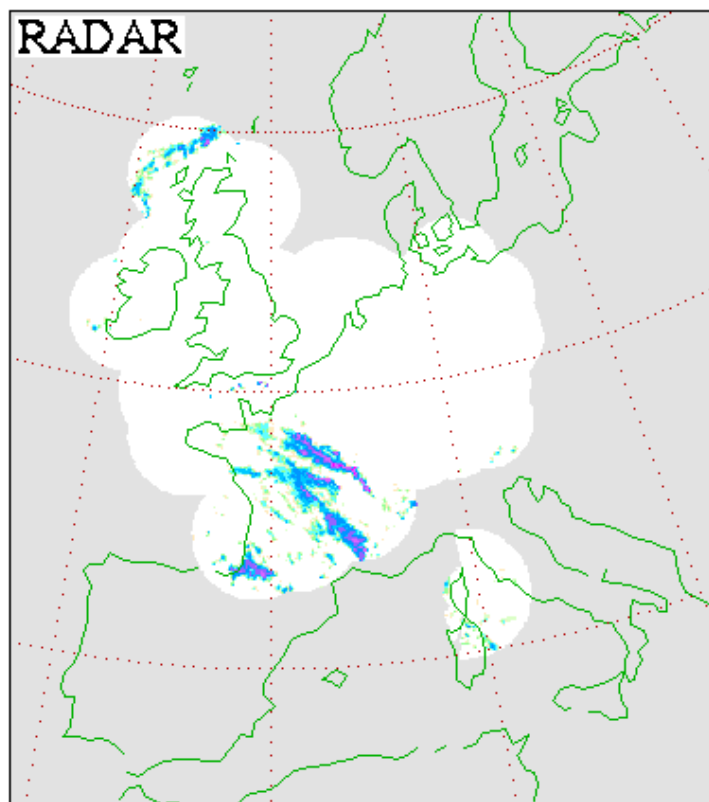
September 2014						
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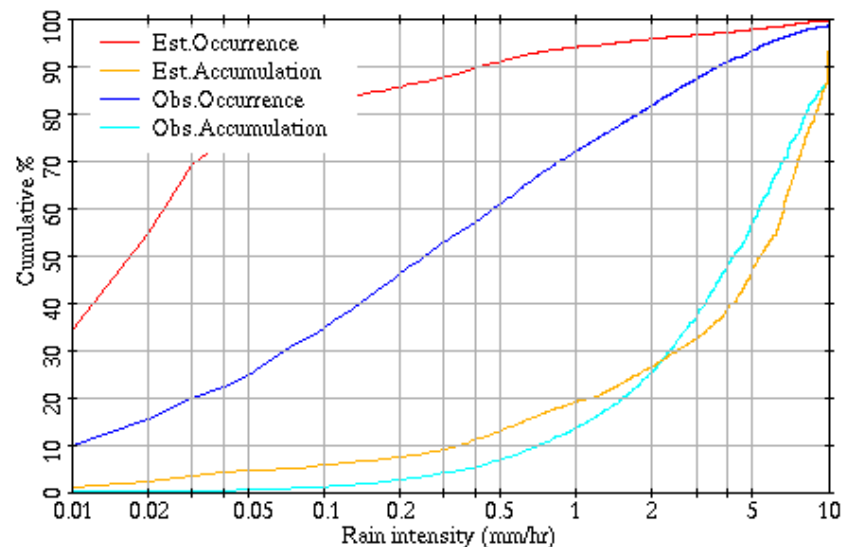
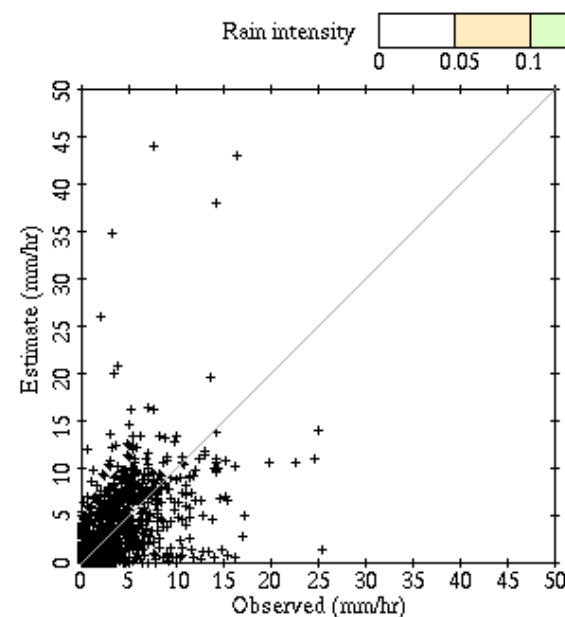
Instantaneous inter-comparison cases for 2016-09-14

sensor	date/time	algorithm	bias	ratio	RMSE	CC	num	nrr	nrr	nrr	rr	pod	far	hss
GCOMW1.AMSR2	20160914.0119	GPROF2014v2-0.V04A	-0.00	0.982	0.353	0.753	33735.	2349.	28822.	48.	2516.	0.981	0.920	0.572
NPP.ATMS	20160914.0156	GPROF2014v2-0.V04A	0.03	1.280	0.965	0.515	6447.	3.	5618.	0.	826.	1.000	0.872	0.355
GCOMW1.AMSR2	20160914.0258	GPROF2014v2-0.V04A	0.04	1.239	1.072	0.482	26475.	2624.	19547.	41.	4263.	0.990	0.821	0.319
DMSPF16.SSMIS	20160914.0447	GPROF2014v2-0.V04A	0.02	1.156	0.529	0.532	17051.	192.	14566.	0.	2293.	1.000	0.864	0.400
NOAA18.MHS	20160914.0646	GPROF2014v2-0.dat	0.01	1.074	0.498	0.458	6342.	2.	5502.	0.	838.	1.000	0.868	0.229
DMSPF17.SSMIS	20160914.0711	GPROF2014v2-0.V04A	-0.00	1.000	0.473	0.531	16768.	99.	14533.	0.	2136.	1.000	0.872	0.478
DMSPF18.SSMIS	20160914.0748	GPROF2014v2-0.V04A	-0.00	0.993	0.341	0.723	15540.	59.	13513.	0.	1968.	1.000	0.873	0.505
METOPB.MHS	20160914.1007	GPROF2014v2-0.dat	0.01	1.155	0.434	0.479	6444.	5.	5765.	0.	674.	1.000	0.895	0.283
GPM.DPR-IR	20160914.1107	V6-20160118.014466	-0.03	0.821	0.517	0.666	7944.	6253.	122.	604.	965.	0.615	0.112	0.498
GPM.DPR-MS	20160914.1121	V6-20160118.014466	0.01	1.074	0.638	0.706	8268.	6530.	113.	641.	984.	0.606	0.103	0.497
GPM.DPR-NS	20160914.1131	V6-20160118.014466	0.02	1.126	0.762	0.662	16164.	13008.	212.	1266.	1678.	0.570	0.112	0.488
GPM.GMI	20160914.1122	GPROF2014v2-0.V04A	0.01	1.113	0.504	0.720	19533.	3181.	13727.	14.	2611.	0.995	0.840	0.515
NPP.ATMS	20160914.1144	GPROF2014v2-0.V04A	0.04	2.116	0.288	0.693	4103.	111.	3745.	0.	247.	1.000	0.938	0.273
GCOMW1.AMSR2	20160914.1231	GPROF2014v2-0.V04A	-0.00	0.950	0.433	0.713	58393.	7170.	44475.	26.	6722.	0.996	0.869	0.462
GPM.DPR-HS	20160914.1253	V6-20160118.014467	-0.04	0.280	0.356	0.349	4604.	4203.	14.	334.	53.	0.137	0.209	0.198
GPM.DPR-MS	20160914.1253	V6-20160118.014467	-0.04	0.406	0.354	0.488	4842.	4388.	20.	355.	79.	0.182	0.202	0.242
GPM.DPR-NS	20160914.1253	V6-20160118.014467	-0.03	0.754	0.503	0.506	8856.	7641.	52.	643.	520.	0.447	0.091	0.439
NOAA19.MHS	20160914.1408	GPROF2014v2-0.dat	-0.04	0.726	0.680	0.421	6694.	5.	5632.	0.	1057.	1.000	0.842	0.341
DMSPF16.SSMIS	20160914.1437	GPROF2014v2-0.V04A	0.01	1.104	0.435	0.721	14810.	182.	12441.	0.	2187.	1.000	0.850	0.550
NOAA18.MHS	20160914.1637	GPROF2014v2-0.dat	-0.01	0.882	0.495	0.622	4402.	5.	3958.	0.	439.	1.000	0.900	0.299
DMSPF17.SSMIS	20160914.1701	GPROF2014v2-0.V04A	-0.02	0.881	0.523	0.735	15670.	116.	12967.	0.	2587.	1.000	0.834	0.526

Ordered by
date/time



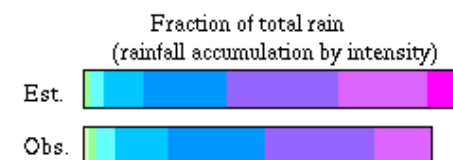
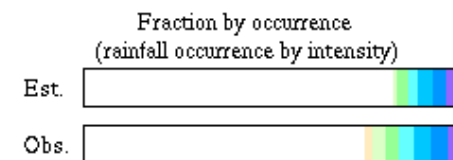
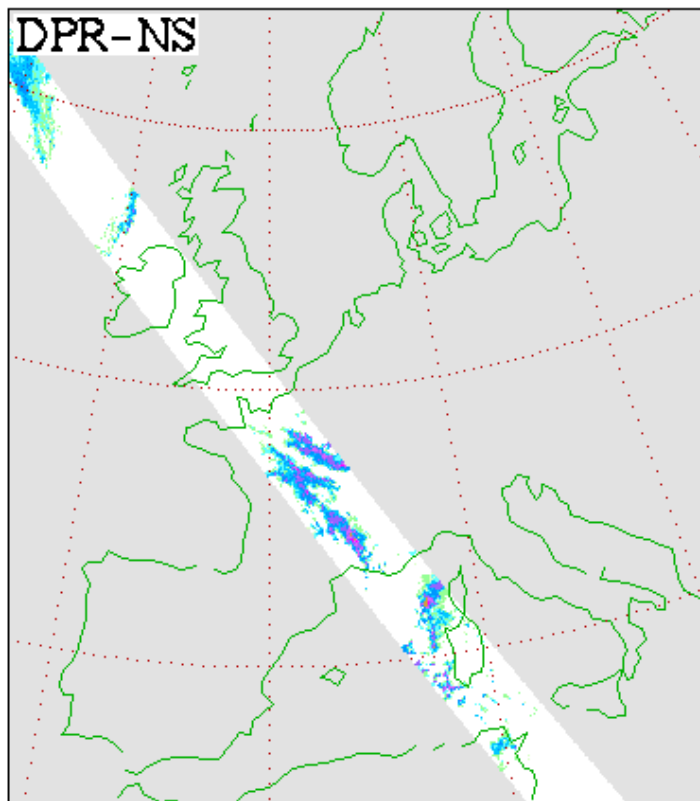
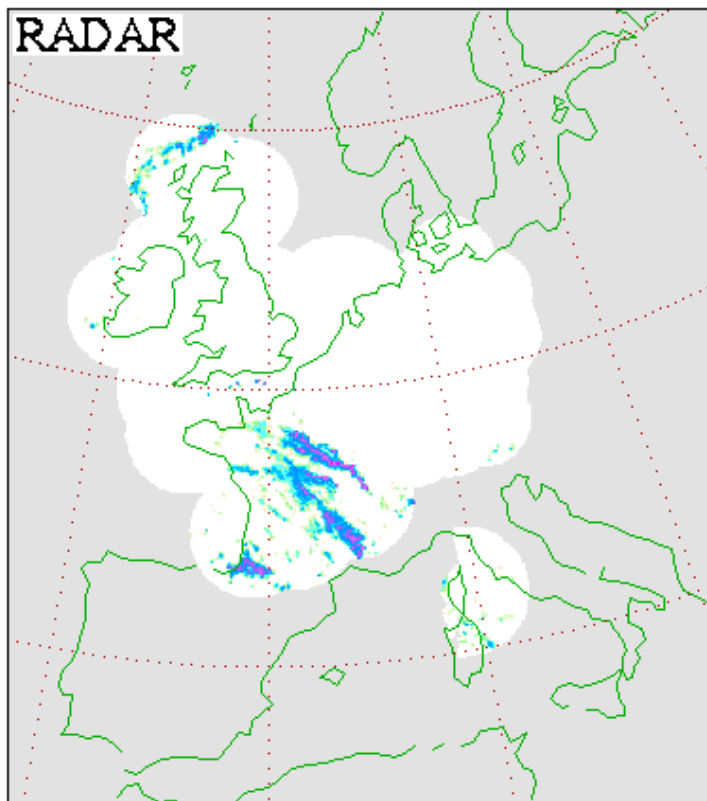
Estimated zero rain		Estimated <1mm >=1mm	
Observed zero	3511. 16694.	Observed <1mm	23198. 138.
rain	71. 4187.	>=1mm	417. 710.
POD 0.983		POD 0.630	
FAR 0.799		FAR 0.163	
HSS 0.571		HSS 0.245	



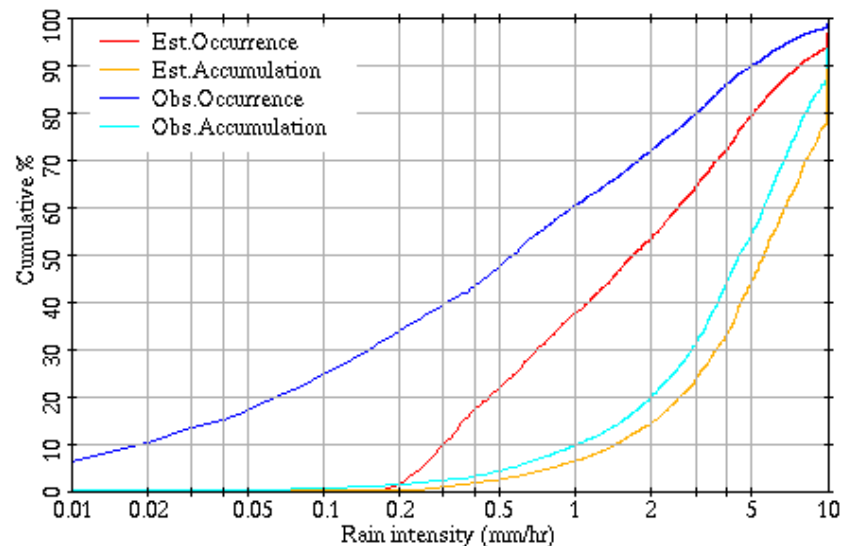
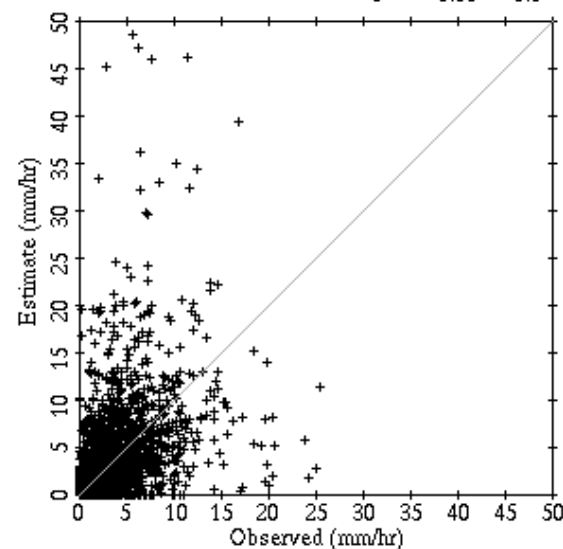
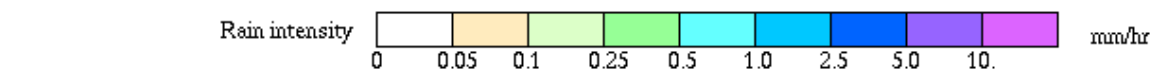
	Observed	Estimated
Number of points	24463.	24463.
Raining points	4258.	20881.
Raining points >1mm	1125.	848.
Mean rain total	0.20	0.20
Conditional rain total	1.16	0.24
Maximum rain total	25.38	43.98

Bias	0.00
Ratio	1.002
RMSE	0.847
Correlation	0.714
#samples	24463.

Instantaneous
20160914_1920



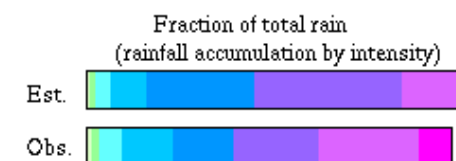
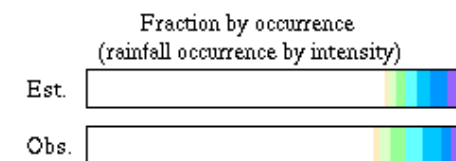
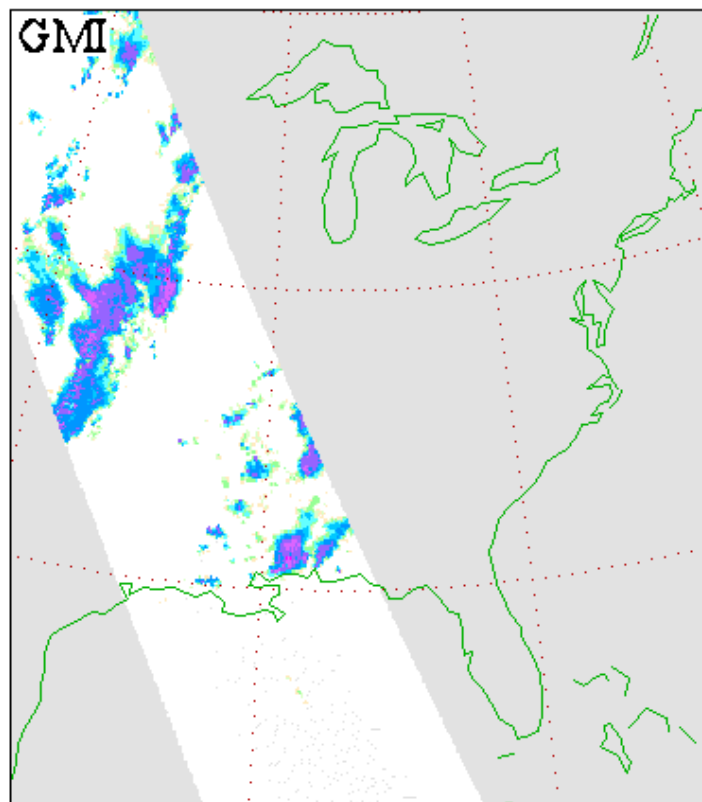
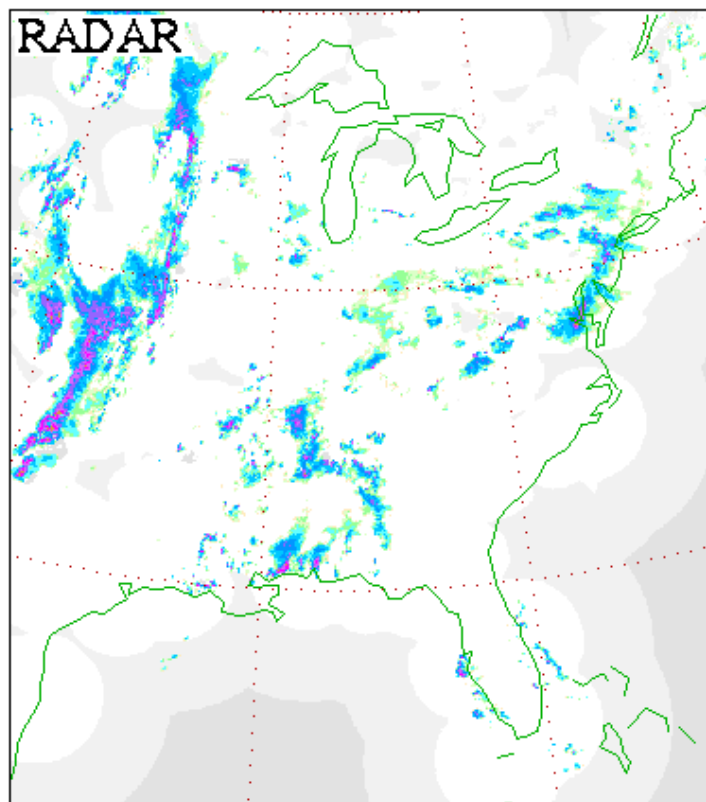
		Estimated zero rain		Estimated <1mm >=1mm			
Observed rain zero		11658.	258.	Observed >=1mm <1mm	13644.	378.	
		1382.	2576.		466.	1386.	
		POD	0.651			POD	0.748
		FAR	0.091			FAR	0.214
		HSS	0.556			HSS	0.143



	Observed	Estimated
Number of points	15874	15874
Raining points	3958	2834
Raining points >1mm	1828	1763
Mean rain total	0.55	0.60
Conditional rain total	2.20	3.36
Maximum rain total	48.78	62.22

Bias	0.05
Ratio	1.093
RMSE	2.123
Correlation	0.563
#samples	15874

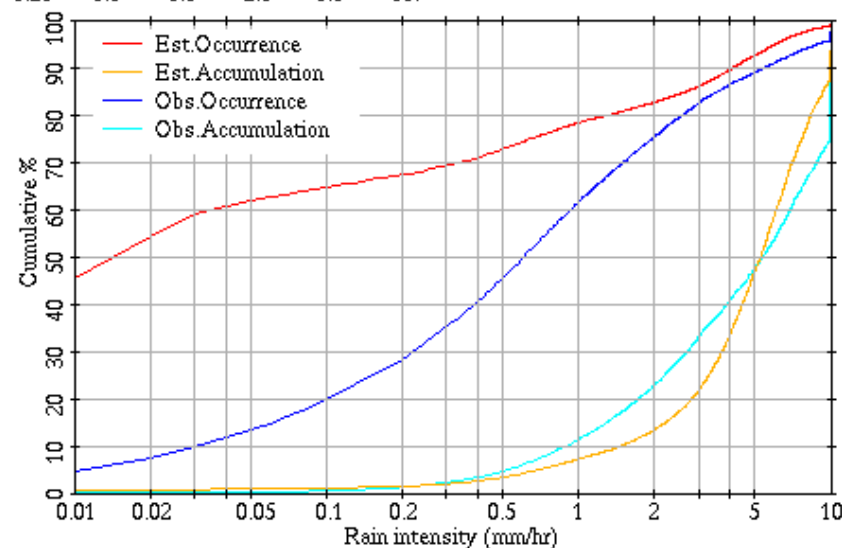
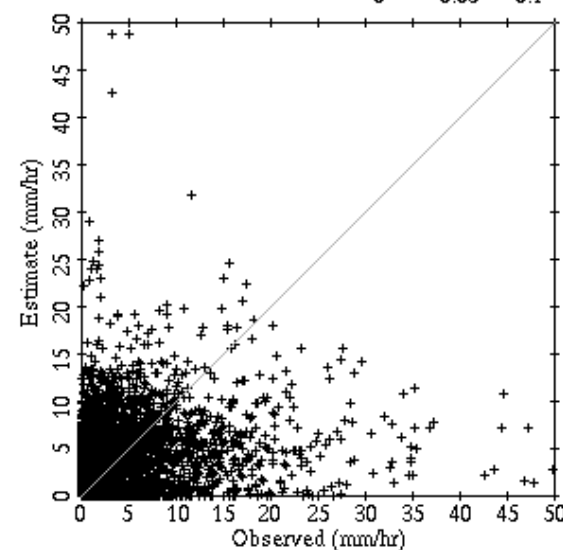
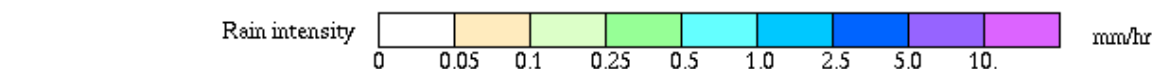
Instantaneous
20160914_1919



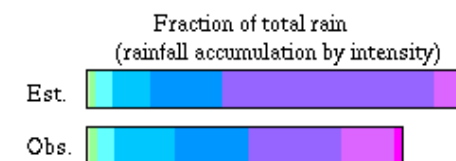
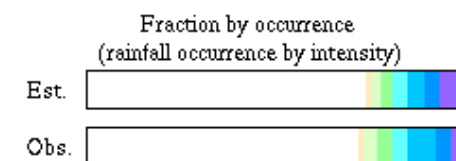
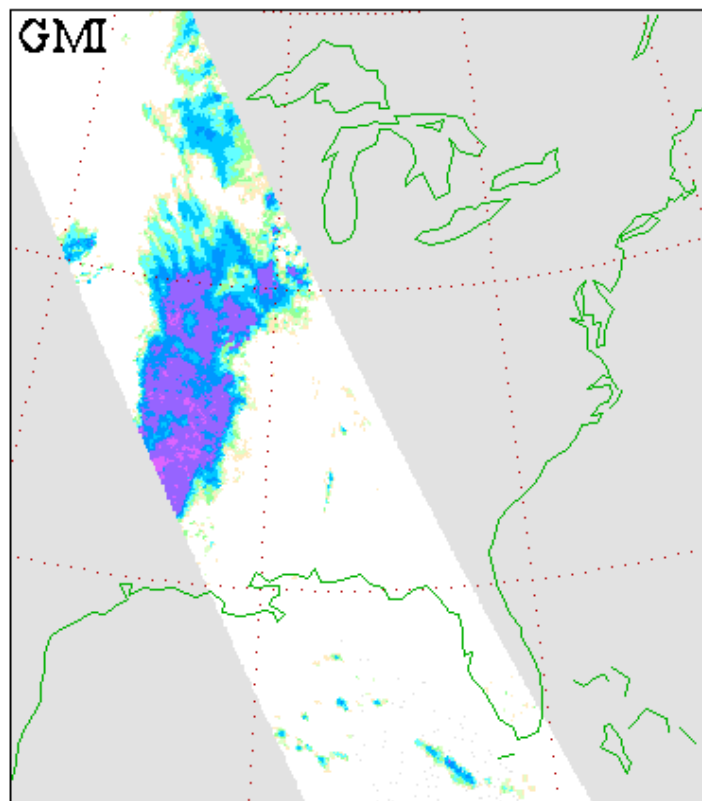
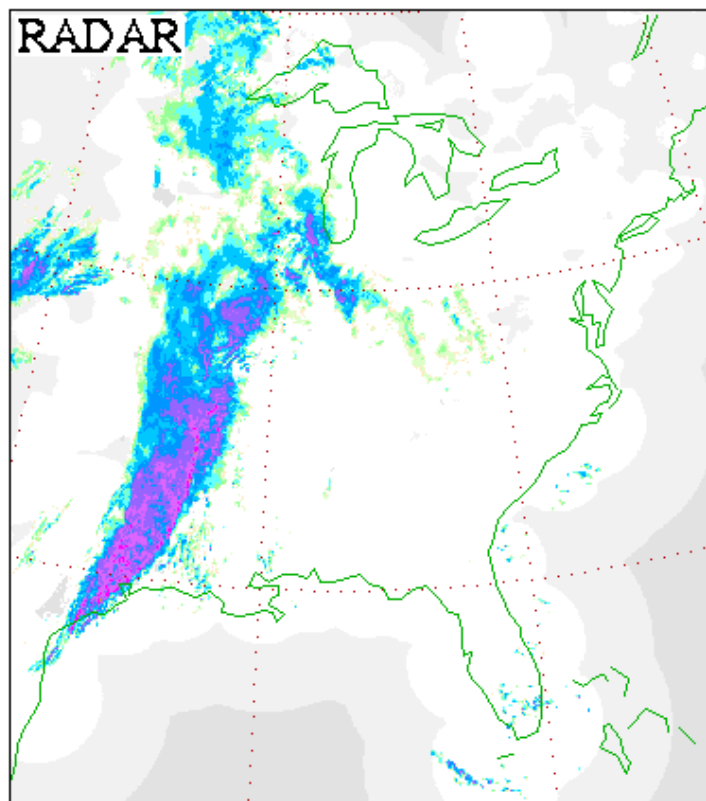
Estimated zero rain		Estimated <1mm >=1mm	
189.	16598.	20962.	1803.
1.	9619.	1276.	2366.
POD	1.000	POD	0.650
FAR	0.633	FAR	0.432
HSS	0.449	HSS	0.061

	Observed	Estimated
Number of points	26407.	26407.
Raining points	9620.	26217.
Raining points >1mm	3638.	4169.
Mean rain total	0.74	0.78
Conditional rain total	2.03	0.79
Maximum rain total	60.78	48.87

Bias	0.04
Ratio	1.057
RMSE	2.554
Correlation	0.457
#samples	26407.

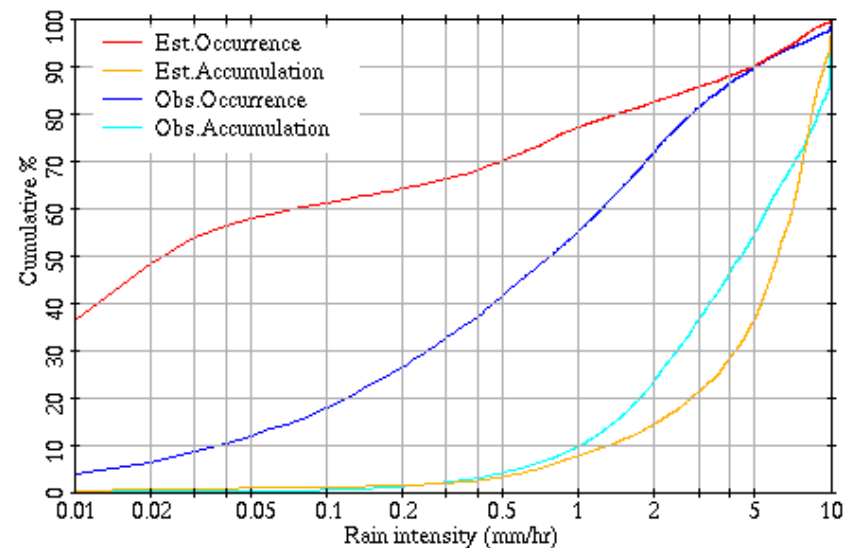
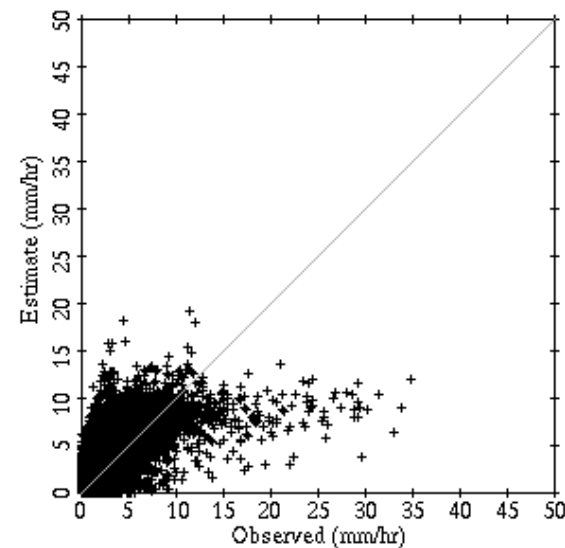
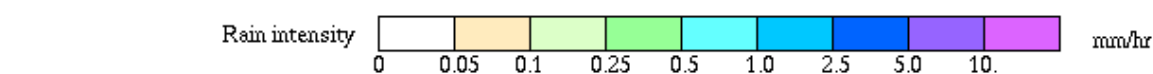


Instantaneous
20150517_0048



Estimated zero rain		Estimated <1mm >=1mm	
Observed zero	286.	18265.	
Observed rain	7.	11682.	
	POD 0.999		
	FAR 0.610		
	HSS 0.593		

Observed <1mm >=1mm		Observed <1mm >=1mm	
Observed zero	23465.	1122.	
Observed rain	1104.	4549.	
	POD 0.805		
	FAR 0.198		
	HSS 0.278		

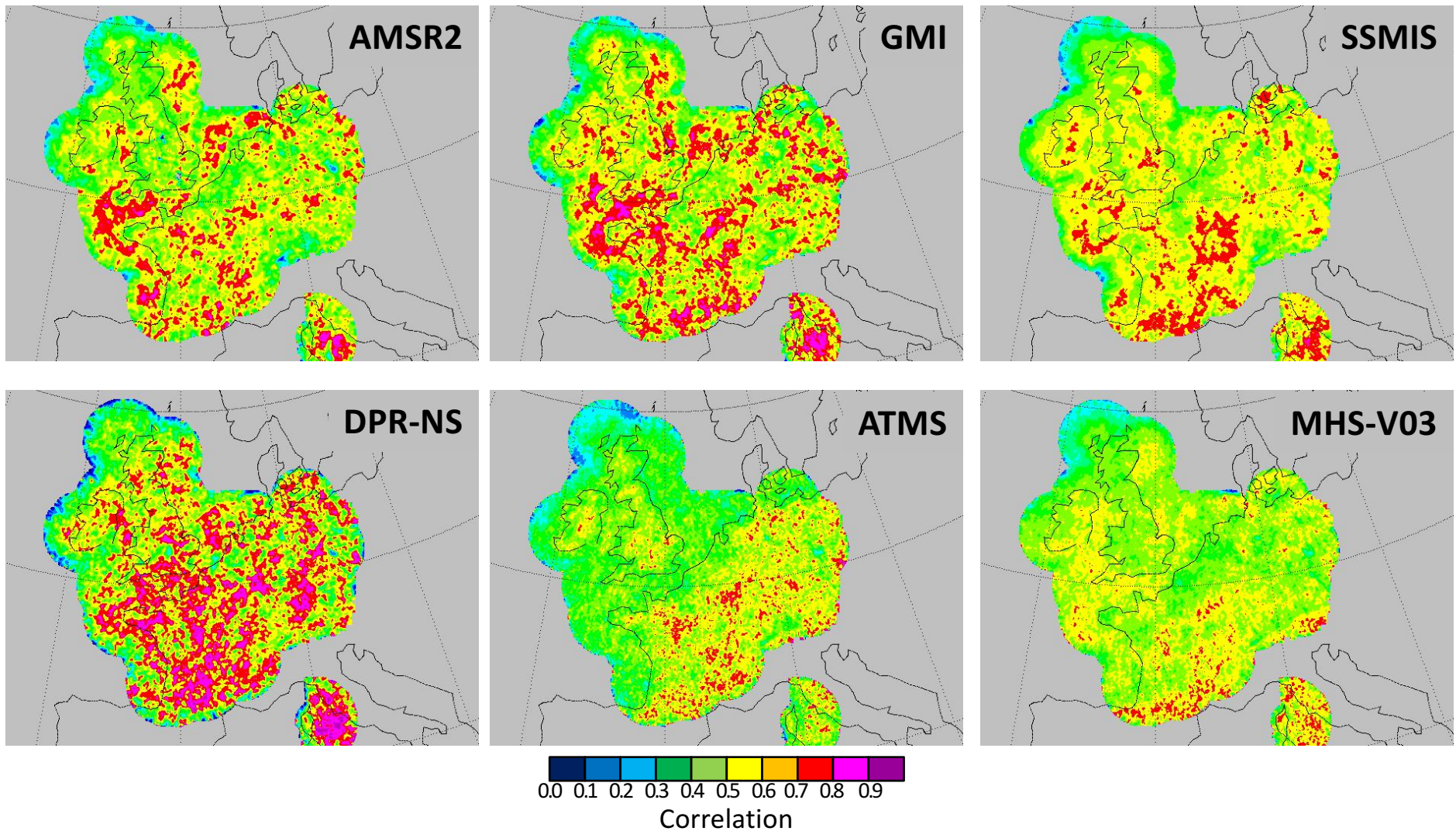


	Observed	Estimated
Number of points	30240.	30240.
Raining points	11689.	29947.
Raining points >1mm	5651.	5670.
Mean rain total	0.80	0.97
Conditional rain total	2.07	0.98
Maximum rain total	34.85	19.15

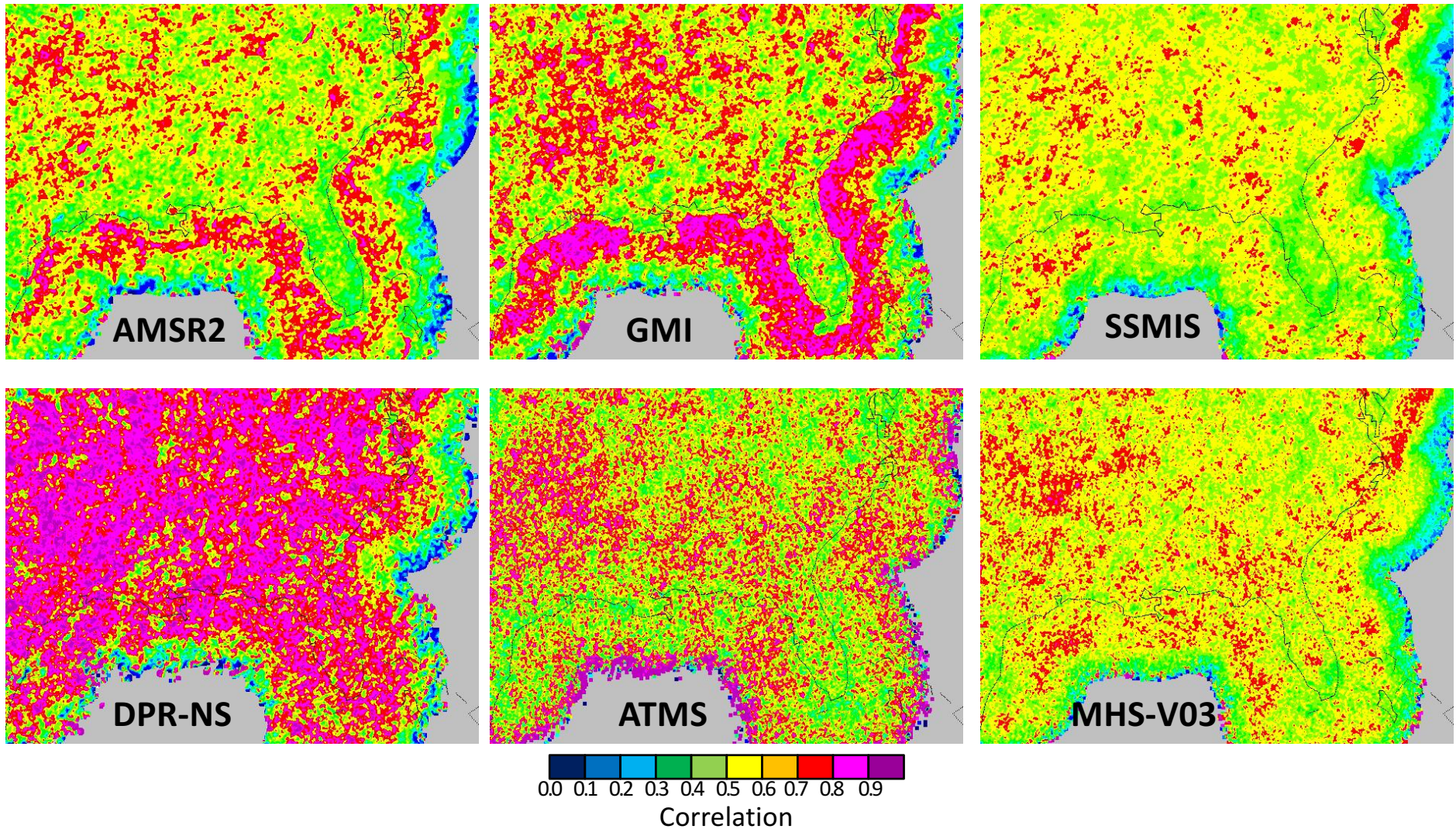
Bias	0.17
Ratio	1.208
RMSE	1.528
Correlation	0.764
#samples	30240.

Instantaneous
20151117_1833

Regional analysis: Western Europe

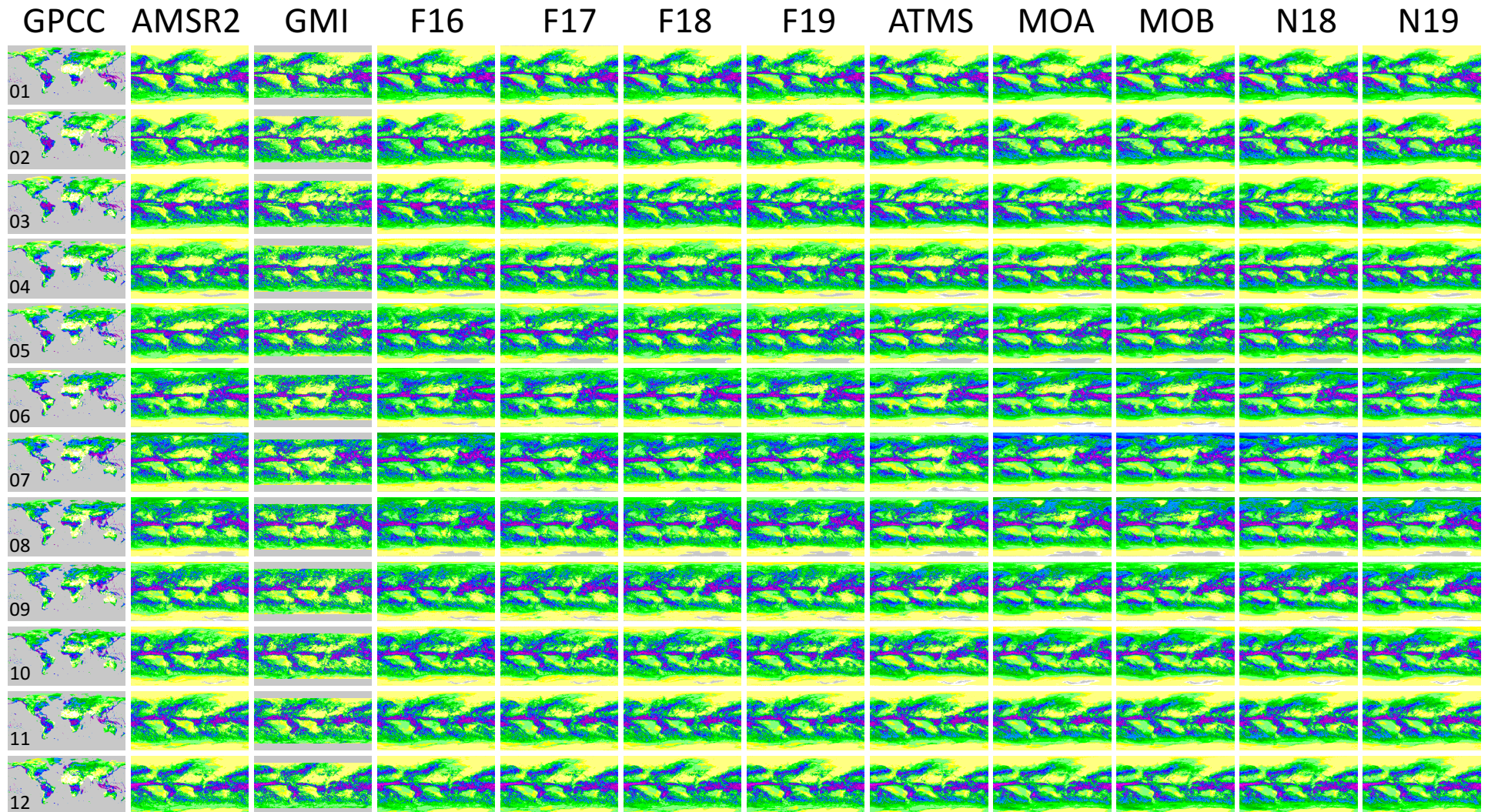


Regional analysis: United States

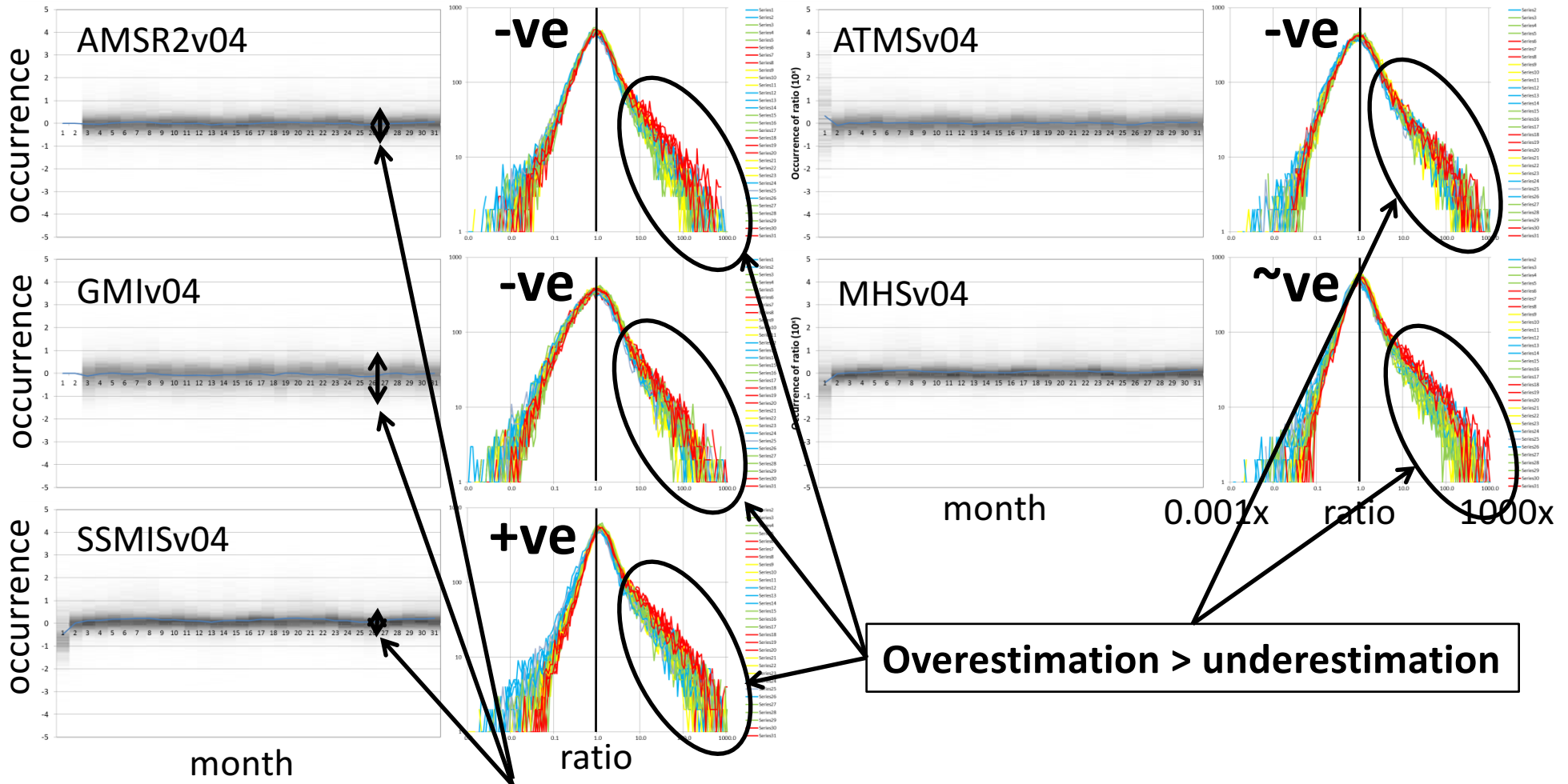


2015:

GPCC (gauge) large-scale validation

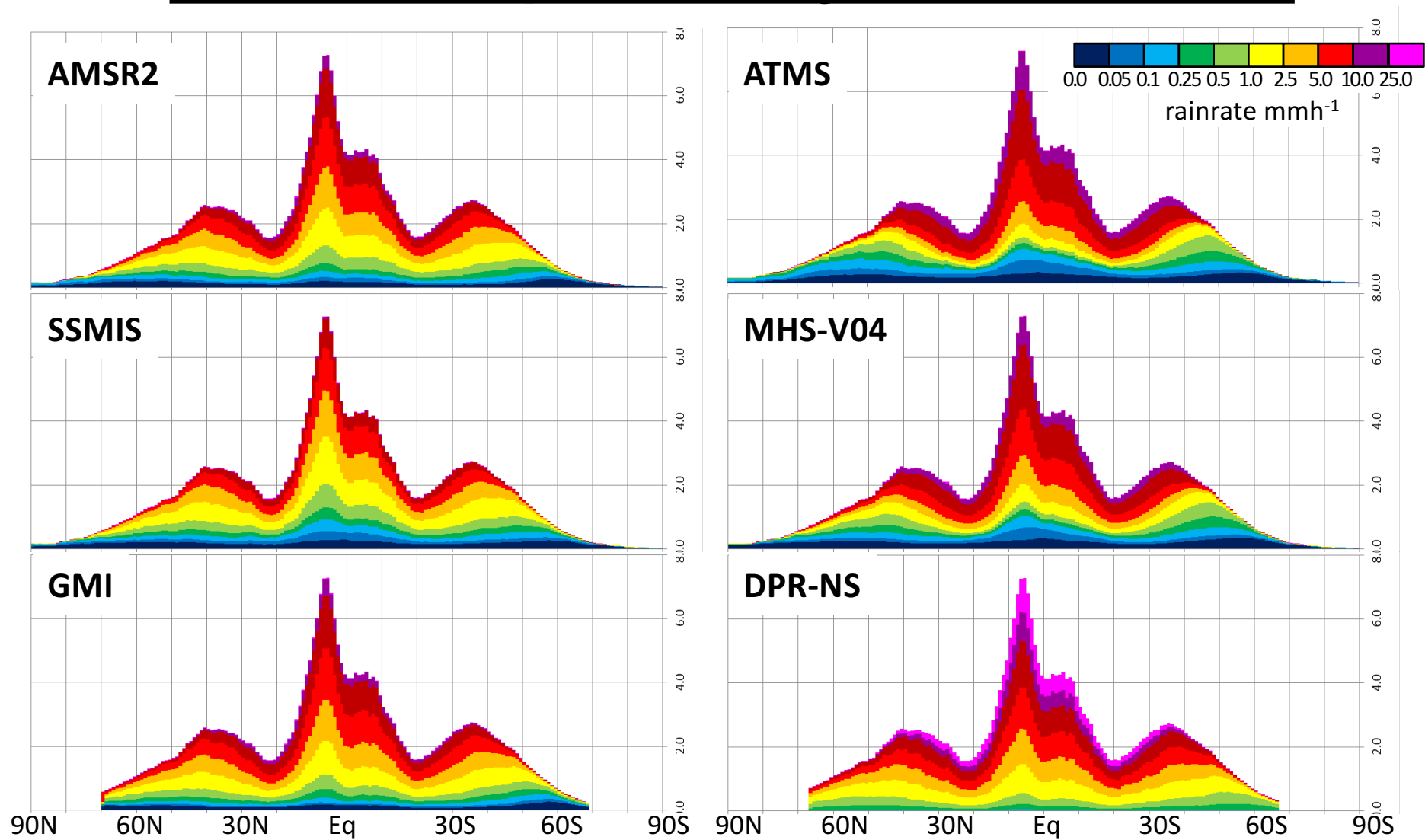


GPCC (gauge) large-scale validation



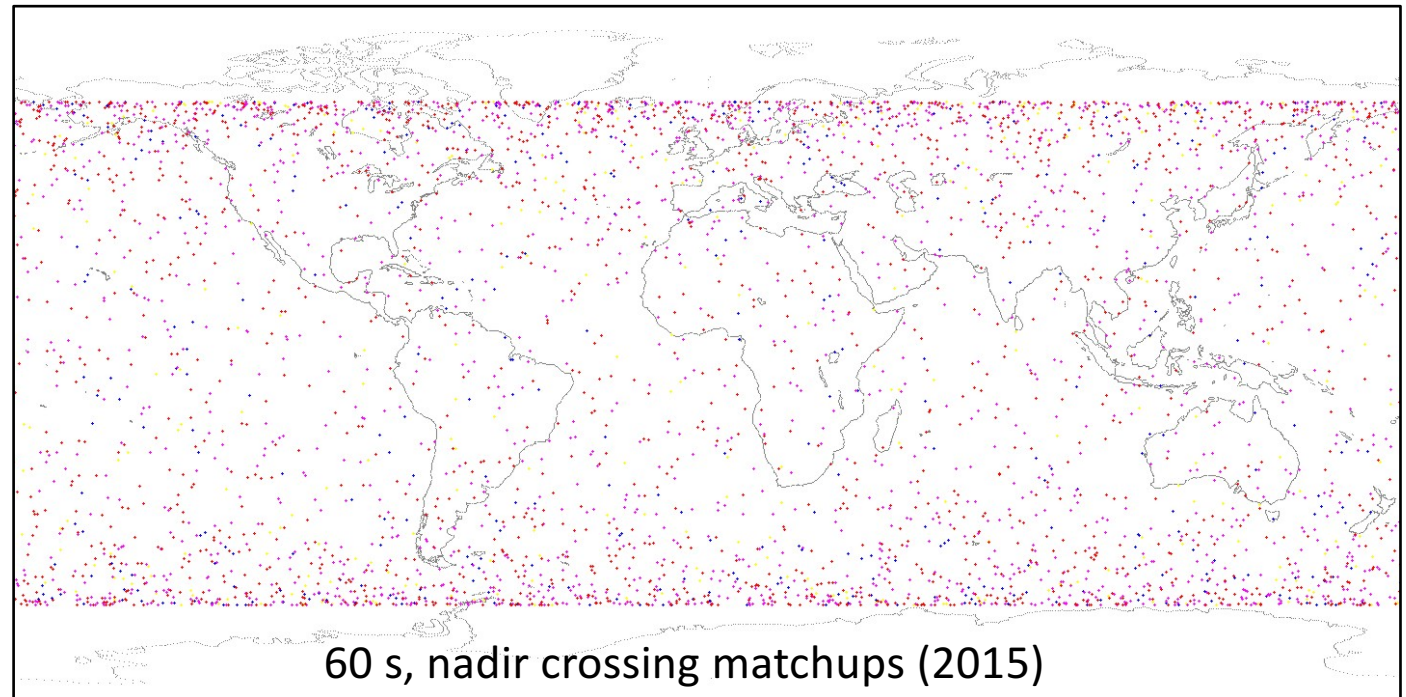
Range of (sat/gauge) ratios relates to number of samples; GMI has the smallest number of samples (1x221), then AMSR2 (1x486) and SSMIS (4x180) with the greatest.

Latitudinal profiles by accumulation



Inter-satellite retrieval comparisons

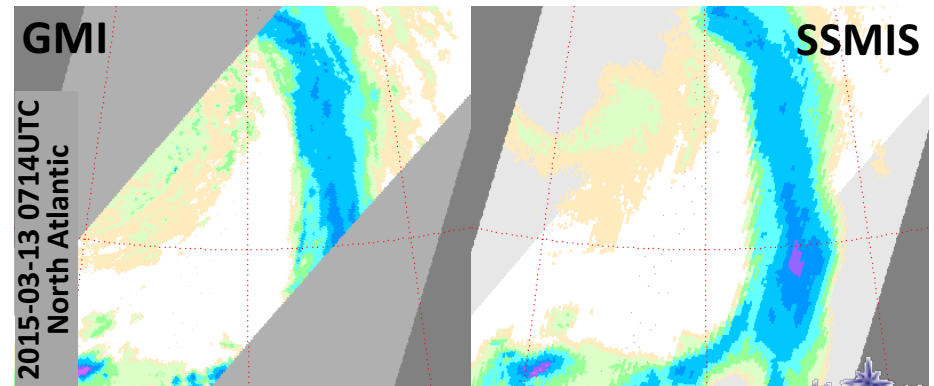
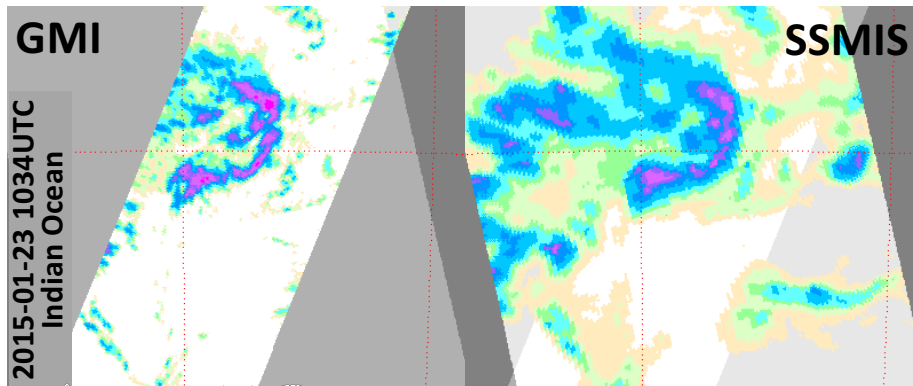
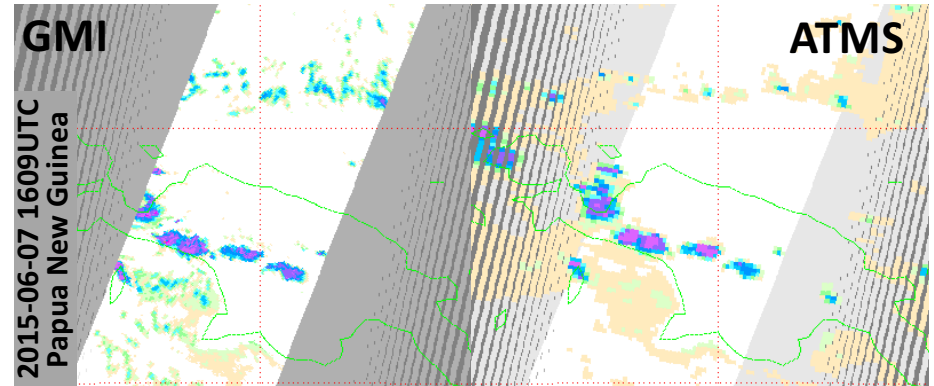
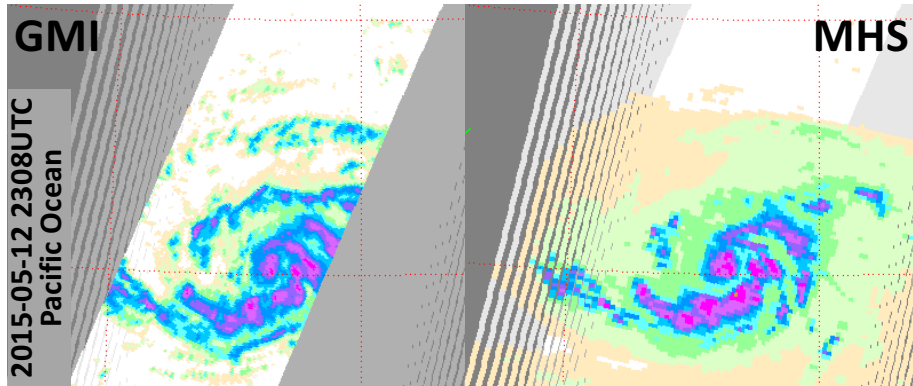
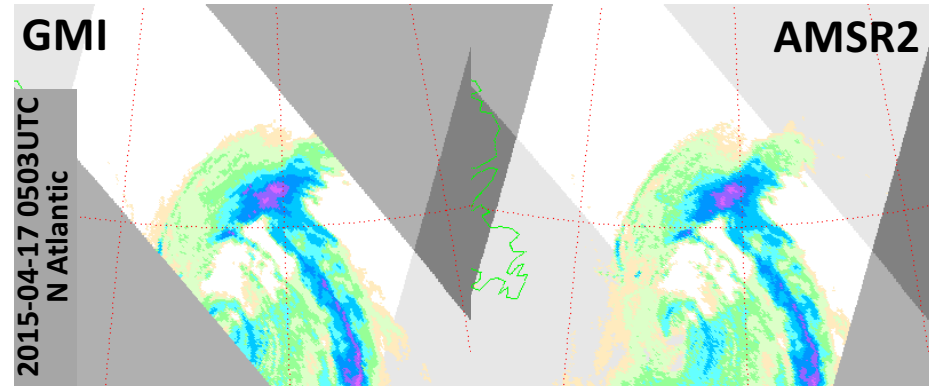
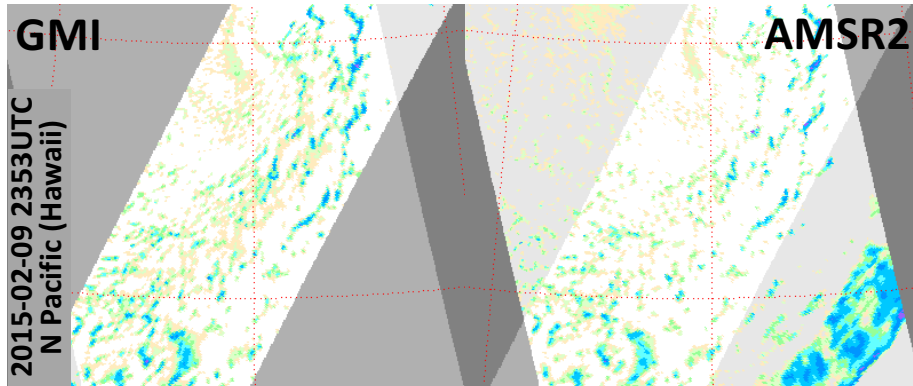
GPM orbit crosses all constellation satellite orbits thus allowing inter-satellite comparisons to be made.



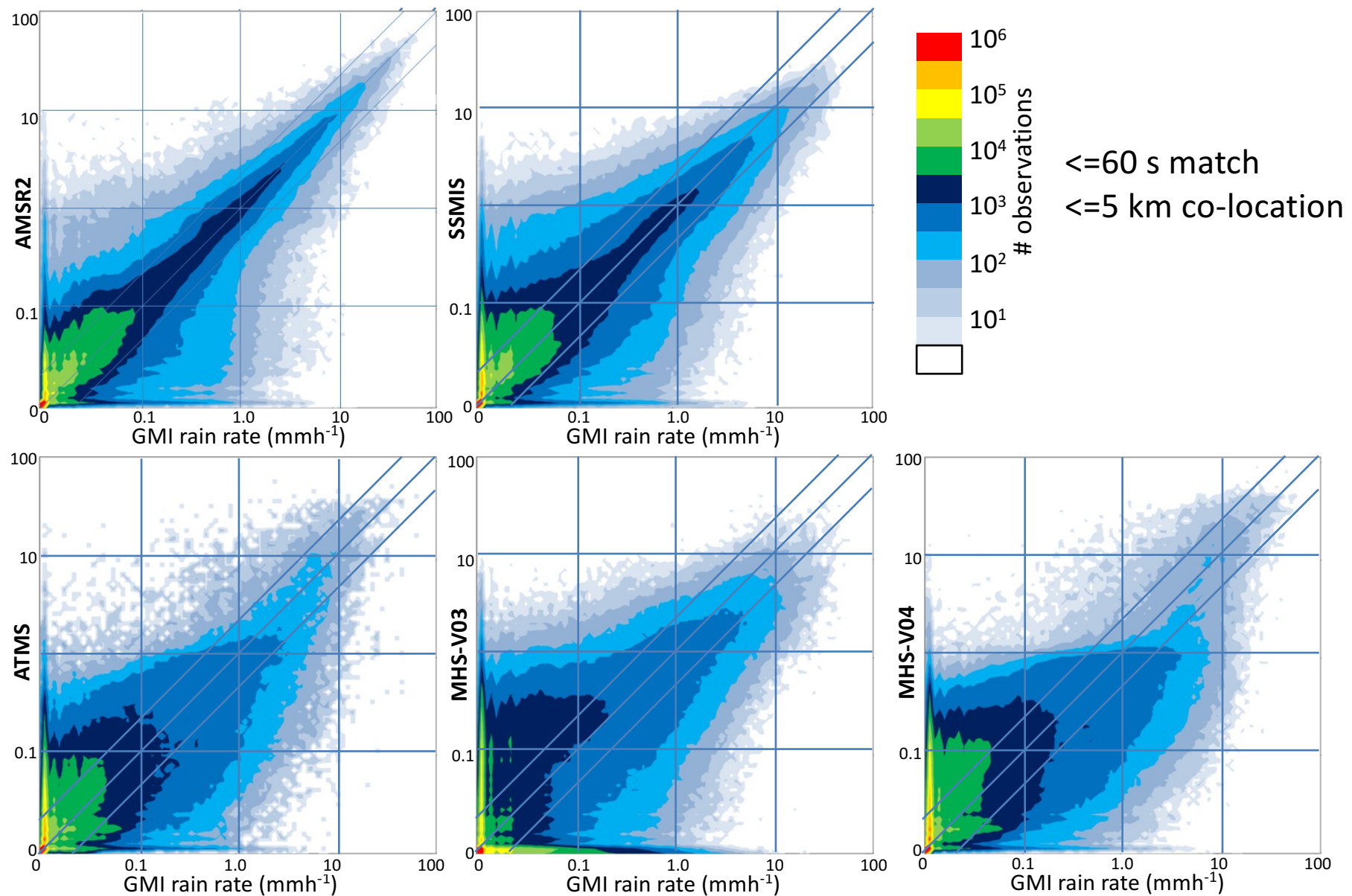
matchups
 $\leq 60s$
 $\leq 5 \text{ km fov}$

GMI-AMSR2	338 cases	6,919,090 fovs
GMI-SSMIS	1673 cases	11,718,314 fovs
GMI-MHS	1732 cases	4,466,330 fovs
GMI-ATMS	444 cases	1,156,309 fovs

Instantaneous matchups



Instantaneous retrievals GMI vs sensor



Summary

IPWG provides support for precipitation research through:

- Workshops, meetings and education
- Representing the precipitation scientific community
- Developing and assessing new techniques
- Providing recommendation for future missions

Current key issues:

- Maintaining current observational capabilities of the precipitation constellation
- Improving access and utilization of surface data sets
- Better interaction with other ISWGs

Future Meeting: IPWG-9 October 2018, most likely in US

Web Page: <http://www.isac.cnr.it/~ipwg>



NASA PMM Science Team meeting, Houston, TX
24-28 October 2016



CGMS

